5.4.7.4 Early Successional Forested Habitat Management Practices

Even-aged management is used to create early-seral forested habitats. Although "clear-cuts" are often associated with even-aged management, there are a variety of even-aged techniques that can be used to accomplish particular management goals. First, it is important to note that "clear-cut" implies that there is no regeneration in place prior to harvest. Even-aged techniques used on Division lands would always be done on stands where some regeneration was in place. Further, complete overstory removal will not be done. Typically 10-20% of the overstory will be retained in clusters of 5-10 trees scattered across the stand. An average of 2-3 clusters per acre will be retained. These occasional clumps of trees are an attempt to mimic natural disturbances. Major catastrophic events typically do not completely remove the overstory in a given area, but instead create a patchy effect on the landscape as some trees survive the event. In addition, preserving clumps of trees allows the Division to selectively save valuable mast, den, and nest trees.

In order to create conditions favorable for early successional species, forest openings need to be large enough and placed appropriately to provide enough habitat to sustain viable animal populations over time. It would be counter-productive to create early successional habitat that was too small and actually serve as a sink habitat for species. Therefore, given constraints on property size, land use, and watershed characteristics, openings on Division lands would not exceed 15 acres. Forest openings of various sizes would be carefully placed within the watershed to ensure adequate water quality protection concerns. Topography, distance to tributaries, soils, stand health, and distance to human interface would be considered when planning even-aged management. Further, when this type of management is introduced, it can provide the catalyst for further study of forest management to determine the short and long-term effects of even-aged management on nutrients and water quality parameters.

5.5 Wildlife Management

5.5.1 Assessment of Impacts of Planned Watershed Management Activities

The management activities described in this plan will have various impacts on the wildlife community at Wachusett. Most impacts on the wildlife community will be a result of habitat changes or modifications. The forest management approach described in this plan has landscape level affects, although individual changes at any given time will be very localized and small.

The amount and types of habitat at Wachusett has been dynamic since early colonial times. Once covered by primeval forest, a majority of the land in the Wachusett watershed was cleared for agriculture. This trend persisted for decades, until about 1840 when 75 percent of the arable land was in pasture or farm crops (DeGraaf et al., 1992). The next 100 years was another period of dramatic change as most of the farmland was abandoned and new forest invaded. Dramatic changes in the wildlife community accompanied these broad landscape changes. Some species thrived and expanded their range, while other were temporarily extirpated or became extinct. When agriculture dominated the landscape, species such as black bears, wild turkeys, and white-tailed deer were gone from most of their former range. Bluebirds were abundant during the agricultural period, but are now very rare breeders. Other open habitat species (bobolinks, vesper sparrows, and golden-winged warblers) are declining as well as available habitat shrinks. Today, most of the undeveloped land in the Wachusett watershed is forested. While the Division's management activities will alter habitat and wildlife species composition, probably the most significant impacts to the wildlife community have been these large regional changes in land use. In addition, recent human population expansion into the Wachusett watershed has meant the loss of more and more open space, which is converted to residential housing. Further, large-scale disturbances to the

landscape such as the flooding of the reservoir, the 1938 hurricane, and periodic fires have shaped the wildlife community that exists today. Future management will be focussed on encouraging regeneration and improving the health and vigor of the forest.

While the management techniques used to reach these goals will not be as dramatic as previous events, it is important to understand how these plans will affect the habitat and wildlife communities on the watershed.

5.5.1.1 General Impacts

The Division's primary long-term forest management goal is to establish and/or maintain a forest cover of diverse native tree species of many different age classes on a majority of its land holdings. This goal will primarily be accomplished through uneven-aged forest management. A 20-30 year cutting cycle will be used in most areas, and harvest will be primarily through selection of individual trees or groups (1/20-1/4 up to 2 acres). As a result, the wildlife community on MDC land will be dominated by species adapted to forest conditions. However, uneven-aged management is the best technique for preserving individual trees of high wildlife value (dens, nests, roost, mast producers) (Payne and Bryant 1994). In addition, uneven-aged management increases vertical diversity. The end result is an even distribution of a low but constant population of understory plants and associated wildlife (Payne and Bryant 1994).

Meeting this primary objective will mean wildlife communities on MDC land will be dominated by species adapted to forest conditions. Those species requiring early successional or open habitat will be rarer and isolated to those areas where that type of habitat exists. Open and early successional habitat will be maintained on a small percentage of the Division's land, primarily associated with fields on recently acquired farms, open areas associated with developed areas (Old Stone Church, dikes), and beaver impoundments. Forest wildlife communities should benefit most from the Division's management plan.

5.5.1.2 Specific Impacts

5.5.1.2.1 Preparatory Cutting and Planting

Preparatory cutting and planting is primarily practiced in stands that either lack adequate understory regeneration or regeneration is lacking species diversity. Prep cuts involve opening up the canopy and may also include disturbing the forest floor and planting selected species. As with most types of active management, this type of silviculture involves trade-offs. Thinning the canopy will stimulate the understory and increase vertical diversity within the stand. This should benefit species requiring a developed understory (eastern towhee, snowshoe hare), but will negatively impact species requiring older, intact forest canopies (northern goshawk, pileated woodpecker). Overall, wildlife diversity within these stands should increase as vertical and species diversity increases, although specific wildlife species may either benefit or decline from the alteration.

Disturbing the forest floor could have a negative impact on those species living on the forest floor, or living in the leaf litter or shallow soil (ovenbird, red-backed voles, and spotted salamanders). However, this impact is temporary and the resultant increase in density of ground cover will be a benefit to these species. Planting desired species within a stand (e.g., conifers) will increase the species diversity of the area and provide a faster amount of understory cover.

5.5.1.2.2 Release of Regeneration

5.5.1.2.2.1 Single-tree Selection

Silvicultural methods proposed during this 10-year plan focus on group selection (~2 acres) removal of overstory trees to release regeneration. In addition, some single-tree selection may also be used. Group selection has a potentially larger impact on wildlife habitat and species than single-tree selection. As mentioned above, single-tree selection essentially maintains an intact forest canopy and is well suited to regenerating shade-tolerant tree species. Those species requiring continuous forest canopy and large tracts of unbroken forest habitat are favored by single-tree selection because the integrity of the habitat is not altered. Many Neotropical migratory forest songbirds (forest warblers, wood thrush, and ovenbird) are edge sensitive species that require unbroken tracts of forest to successfully breed. When single trees are removed from the forest, no edge or transition habitat is created and the forest interior is maintained. While this will benefit these edge sensitive species, those species (ruffed grouse, white-tailed deer, eastern towhee, chestnut-sided warbler) that rely on edge habitats will be limited to areas where it exists.

5.5.1.2.2.2 Group Selection

Much attention has been focussed recently on the potential problems of forest fragmentation in the northeast. Most of this effort has centered on Neotropical migrantory birds and the continued decline of some species. It has been shown that area-sensitive songbirds do not reproduce well along edge habitats (Sullivan and Brittingham, 1994). In most cases, when trying to conserve edge-sensitive species, it is recommended that extensive areas of contiguous forest are maintained and the amount of edge habitat minimized. Because the Wachusett watershed is a mosaic of habitat types and represents a fragmented landscape, it is hard to speculate how much impact MDC land management activities will have on edge-sensitive species. Alterations to MDC forested land are not analogous to what would occur if the same land were developed for residential housing or agriculture. However, since the MDC will use group selection (openings up to two acres in size) to treat the majority of Wachusett forest stands, it is prudent to consider the impact of this practice on wildlife communities.

The most influential factor associated with this type of silviculture would be the introduction of edge effects. Many studies have documented the reduced nesting success of songbirds near forest edges when compared to the interior (see Wilcove, 1988). This reduced success is a result of nest predators (blue jays, chipmunks, raccoons, crows) and/or nest parasites (brown-headed cowbird). In addition, rates of cowbird parasitism increase near openings within large forest tracts (Wilcove, 1988). Initially it might appear that edge effects would be limited to isolated woodlots surrounded by houses or barren land. On MDC land there is primarily a matrix of interconnected forest at different stages of succession. Unfortunately, edge effects are applicable to forest ecosystems because small openings within forests create edges.

Although most changes in vegetation caused by group selection extend only 30-100 feet into the forest, increases in nest predation and parasitism may extend as far as 1000-2000 feet into the forest. Therefore a small number of openings in the forest could impact a large area. Adding to the problem could be the nature of the Wachusett watershed. MDC land often abuts other non-forested areas or small woodlots where large numbers of nest predators potentially live and reproduce (residential areas support cats, raccoons, bluejays, etc.). Therefore, predation rates could very likely be higher in the adjacent forest openings.

Impacts of fragmentation on mammals are less well known. It is likely that species most sensitive to forest fragmentation were extirpated long before they could be studied. Mountain lions, wolves, elk, and woodland bison have been gone from the watershed for decades. As a result, those mammals left within the watershed are the ones adapted to surviving in fragmented, human-altered landscapes. It is likely that the main limiting factor on mammal populations is human disturbance and not fragmentation.

Openings within forests benefit wildlife species that depend on herbaceous and early successional forest habitat. Wild turkey, ruffed grouse, eastern towhee, red-shouldered hawk, and white-tailed deer will benefit from the proposed openings. Forest openings will allow for denser ground cover, increased light, and a more open canopy. This type of habitat favors certain species of wildlife.

5.5.1.2.2.3 Large OverstoryRemovals in Plantations

Full overstory removals in plantations produces the greatest immediate habitat change due to silviculture on MDC/DWM properties. Full overstory removal is essentially even-aged management and involves both positive and negative effects on wildlife. In general, removing the overstory will provide excellent early successional habitat that is utilized by a variety of species. Early successional species will particularly benefit from this management because the larger stand size will attract and sustain larger populations of those species. Species requiring continuous forest canopy will be impacted by these treatments. In addition, species utilizing conifer-dominated habitat (red squirrels, some Neotropical migrants, nesting raptors) may be displaced by the removal of conifer plantations.

5.5.1.2.2.4 Non-harvest Removals on Sensitive Sites

There are areas on the watersheds where a reduction of overstory trees is desireable in order to diversify age structure, but where conventional harvesting may be impossible or risky (e.g., a shoreline plantation or a hurricane exposed island). On a limited number of these sites, the Division proposes to cut trees but not remove them. This practice would enhance forest regeneration without negatively impacting the sensitive site. Non-harvest tree cuttings will also add course woody debris to an area, particularly large size log classes that are important to a variety of wildlife. In addition, removing some canopy trees will increase species diversity and enhance the ground and shrub layer of the area. This type of management is being proposed on less than 100 acres on the Wachusett watershed, so it will have little impact on wildlife species at the landscape level.

Cutting trees along the reservoir shoreline could impact the potential for bald eagle nesting. There are no bald eagle nests along Wachusett Reservoir to date. However, if large “supercanopy” trees are removed, it may impact the ability of eagles to nest in the future. Careful attention will be given to providing adequate nest trees along the shoreline.

5.5.1.2.2.5 Riparian Zone Management

The Division plans to conduct limited non-harvest removals of trees along riparian wetlands to increase light and stimulate regeneration. Cut trees will be left in place along the riparian area. This will add coarse woody debris, providing additional cover and nutrients for forest floor wildlife. The additional

light will allow for a greater diversity of understory trees and ground cover, which will benefit wildlife species that rely on dense understory vegetation.

This management practice could have potential negative impacts on the wildlife community depending on where the harvesting was to occur and how many overstory trees were removed. Removing a large number of deciduous trees along the riparian zone could have negative effects on species requiring large expanses of continuous wooded streams. However, if single trees or small groups are removed, these impacts would likely be minimal. On some streams there is almost continuous conifer (hemlock) cover, which characteristically has little understory regeneration. This habitat type is uncommon on the watershed and provides unique habitat for a variety of wildlife. Removing trees in these areas could alter the microclimate of the area and have potentially negative effects on the wildlife and stream communities. When harvesting trees along the riparian area it is important to save cavity or potential cavity trees. Cavity trees along riparian wetlands are extremely valuable to a range of wildlife species.

A final consideration regarding this management technique would be to recognize that stimulating regeneration and new growth along riparian wetlands might be beneficial to beaver populations. Availability of a winter food supply is an important factor affecting beaver distribution in areas where stable water levels are possible.

5.5.2 Conservation Management Practices (CMPs) for Wildlife Management

Division foresters are concerned primarily about maintaining water quality standards and improving forest health and vigor. Monetary gain from forest resources is a minor consideration when planning management activities. A direct result of this flexibility is that it allows Division foresters to incorporate sound and beneficial wildlife management components into their forest cutting plans. High quality mast trees, active and potential den and nest trees, and critical habitat has been and continues to be conserved and encouraged on Division property.

CMPs for wildlife management are generally complementary to water quality protection standards. The following wildlife CMPs highlight current management techniques already being practiced and elaborate on other management techniques that can be employed.

5.5.2.1 Habitat Features and Management Recommendations

5.5.2.1.1 Vernal Pools

D. Clark

Vernal pool

Vernal pools are contained basin depressions with no permanent outlet that typically hold water for at least 2-3 months in the spring and summer. Vernal pools may or may not dry completely each year, but their periodic drying, shallow water, winter freezing, and low oxygen levels keeps them free of fish populations.

Because of their unique characteristics, vernal pools play a critical role in the life cycles of many amphibians, reptiles, and invertebrates. As a result, the MDC considers vernal pools to be a critical wildlife habitat. In fact, many state-listed species are associated with or dependent on vernal pools. Many vernal pools dry completely during the late summer and fall and can be difficult to identify. In recent years, the MDC has made efforts to locate and identify vernal

pools during the spring. Accurate and detailed records of located pools, including UTM coordinates and animal use, are stored in databases. In addition, the University of Massachusetts, Amherst recently identified over 300 "potential" vernal pools on the Wachusett watershed through aerial photos. These pools have been digitized, and in the future, these pools will be field checked to ascertain their status. Locations of known documented vernal pools will be transferred to a GIS datalayer for inclusion in land management planning documents.

Research is currently being conducted at Quabbin Reservation to test the effectiveness of Massachusetts Conservation Management Practices for vernal pools. While the state CMPs provide direct protection of the pool, there is concern that the wildlife species utilizing the pool may also rely on a larger area surrounding the pool for a majority of their life cycle. This research will test the effectiveness of the current CMPs.

5.5.2.1.2 Vernal Pool Management Objectives

MDC/DWM is working to locate and identify all vernal pools on MDC property and maintain vernal pool depressions in an undisturbed state.

Recommended Practices:

- Seek additional input from NHESP when management activities are going to occur around a pool that contains state-listed species.
- Digitize all aerially intrepreted vernal pools and provide datalayer to GIS personnel for inclusion in land management activity plans.
- Identify and confirm status of photo-intrepreted vernal pools.

Within Pool Depression:

- Continue to maintain physical integrity of pool depressions and their ability to seasonally hold water.
- Continue to keep depressions free of slash, treetops, and sediment from forestry operations. If slash does fall into pool during the breeding season do not remove it so breeding activity is not disturbed.

Edge of Pool:

- Keep shaded condition in 50-foot buffer zone around pool depression.
- Minimize disturbance of forest floor within 200 feet of pool edge.
- Avoid making ruts >6 inches deep within 200 feet of the pool.
- Conduct low-intensity harvests preferably when ground is frozen.

5.5.2.1.3 Seeps

Woodland seeps tend to be small (< ¼ acre) areas where ground water flows to the surface of the forest floor and saturates the soil. Seeps generally do not freeze during the winter and typically have little

or no snow cover. Seeps often occur in natural depressions and may act as "seed traps" in which nuts, seeds, and fruits from surround trees and shrubs accumulate. This makes them important winter feeding sites for turkey, deer, and other wildlife.

Seeps provide a seasonally important source of food and water for resident and migratory wildlife (Hobson et al., 1993). These areas tend to have early sources of green vegetation. This can be an important food source for black bears in the spring and early summer. Earthworms and insects at seeps attract early migrants such as robins and woodcock. Spring salamanders and hibernating frogs, which can attract skunks and raccoons, may also use seeps.

D. Clark

Winter seep

5.5.2.1.4 Seep Management Objectives

MDC/DWM will continue to protect seeps, springs, and surrounding soils.

Recommended Practices:

- Avoid leaving slash in woodland seeps or springs.
- Maintain mast-producing trees above and around seep.
- Remove conifer trees on south side of seep; retain conifers on north and west sides.
- Where seeps are present, schedule harvests to occur on frozen ground or during the driest conditions.
- Avoid running heavy equipment within 50 feet of the edge of a seep.
- When feasible, use seeps as the center for uncut patches to retain cavity trees, snags, and other wildlife features.
- In stands where seeps are present, lay out skid trails and roads prior to the harvest when seeps are obvious.

5.5.2.1.5 Orchards

Abandoned apple orchards and scattered fruit trees exist on MDC watershed property. Wild apple trees are one of the most valuable wildlife food species in the Northeast (Elliot 1998, Tubbs et al., 1987, Hobson et al., 1993). White-tailed deer, grouse, squirrels, fox, fisher, porcupine, and rabbits will eat apples or apple seeds. Apple trees also provide nesting and perching habitat for bluebirds, flycatchers, robins, orioles, and sapsuckers (Elliot 1998). Apple trees in abandoned orchards eventually become crowded by invading shrubs and over-topped by the encroaching forest. Prolonged crowding and shading will lead to decreased vigor and eventually death.

5.5.2.1.6 Orchard Management Objectives

MDC/DWM will save apple and other fruit trees when possible and increase their health and vigor when feasible.

Recommended Practices:

- Continue to identify abandoned orchards and clusters of fruit trees.
- If possible, keep and enhance all fruit trees.
- When feasible, remove other trees and shrubs back to the drip line of the apple tree.
- If large over-topping trees shade the fruit tree, remove them on at least 3 sides, particularily to the south.
- When possible, prune and fertilize trees at least every 3 years.

5.5.2.1.7 Wildlife Wintering Areas

P. Rezendes

Winter deer yard

Wildlife wintering areas (WWA) provide shelter and food for animals during the winter months when cold temperatures, snow cover, and limited food resources create physiologically demanding conditions. An important wintering area is often related to white-tailed deer use of concentration areas or "yards." These deer wintering areas (DWA) typically are in hemlock or pine stands where there is >70 percent conifer crown closure (Elliot 1998). Deer typically move to these areas when snow depths are around 12" (Flatebo et al. 1999). DWA provide reduced snow depths, higher nighttime temperatures, reduced wind, and greater relative humidity (Flatebo et al. 1999). These areas must not only provide adequate cover, but also a quality supply of deer food. Cedar, red and sugar maple, birch, and hemlock are preferred foods. Another important wintering area is dense conifer cover (i.e., spruce stands) that provides increased thermal protection and wind cover for a variety of birds and mammals. For example, grouse will seek conifer stands when snow depths are <8 inches for thermal protection.

The general guideline for wildlife wintering areas is to maintain as much overstory as possible, while providing for the establishment and continued growth of preferred browse and conifer tree species.

5.5.2.1.8 Wildlife Wintering Area Management Objectives

MDC/DWM will maintain the functional value of wildlife wintering areas.

Recommended Practices:

- Identify and map all known or potential WWA using aerial photos, cover type maps, and field inspections.
- When feasible, schedule forest harvest operations during December-April within WWA so treetops are available for browse.
- Protect advanced conifer regeneration during timber harvesting.
- Cut stumps low to encourage vigorous sprouting.
- Planned activities within WWA should be conducted to ensure that at least 50% of the wintering area remains in closed canopy coniferous overstory to provide functional shelter.
- Avoid concentrating harvest in any one area of the WWA.
- Try to maintain travel corridors (unbroken, dense softwood cover 60-100m wide) that connect all areas of the WWA.

5.5.2.1.9 Mast

Mast is a critical component of quality wildlife habitat. Trees, shrubs, and vines produce fruits, nuts, and berries called mast. Mast can be hard (nuts, seeds) or soft (fruit, berries). It contains more fat and protein than other plant foods and is actively sought by a variety of birds and mammals. Mast is particularly important in autumn, as many animals will focus on eating mast in preparation for winter. Bears, squirrels, raccoons, deer, and turkey will fatten up on acorns, beechnuts, and hickory nuts. Resident songbirds such as nuthatches, chickadees, and bluejays rely on mast during winter when other food is scarce. Migrating birds will often rely on fruits and berries during migratory stops to replenish energy.

Although all trees and shrubs are defined as mast producers, some species are more important to wildlife. The value of mast to wildlife differs with the size, palatability, accessibility, nutritional content, abundance, and production frequency (Flatebo et al. 1999). In general, oak, hickory, beech, walnut, butternut, cherry, ash, and conifers are the most important mast trees. In addition, birch, hazel, alder, and aspen are also important to some wildlife species.

5.5.2.1.9.1 Hard Mast

At Wachusett, red, white, and black oak, beech, and hickories are the most important sources of mast. Oaks are probably the most important wildlife mast trees in the northeast. Acorns are eaten by over 100 species of birds and mammals (Healy 1997). The frequency and characteristics of oak production varies from species to species. Red oaks produce a good crop of acorns every 2-5 years, black oaks every 2-3 years, and white oaks every 4-10 years. Red and black oak acorns take 2 years to develop, while white oaks take only 1 year. Peak acorn production begins at around 25 years for red oaks, 40 years for white oaks, and 40-75 years for black oaks (Flatebo et al. 1999). White oak acorns contain less tannin and may be more palatable to wildlife.

Beech and hickory trees comprise a smaller component of Wachusett's forest. Hickories are scattered around the watershed, usually interspersed with oaks. They have good seed crops every 1-3 years and begin producing quality crops at 40 years. Hickory nuts have one of the highest fat contents of any mast. Beech trees occur irregularly across the watershed. The prevalence of beech bark disease and low market demand has shifted attention away from this species. However, beechnuts can be an important source of food for a variety of wildlife. Wild turkeys prefer beechnuts to all other mast (Williamson undated).

The seeds of maples, birches, ashes, and conifers provide food for many birds and small mammals. Red squirrels rely heavily on conifer seeds and their populations will fluctuate in response to annual crops. Birches are important mast producers because most of the seed crop is retained on the tree above the snow. Birds, including pine siskins and grouse, count on birch seeds for their winter diet. White and red pine are the most widely distributed conifers at Wachusett. Mice, voles, grosbeaks, and finches are a few of the animals that utilize conifer mast. Chickadees and goldfinches prefer hemlock seeds.

5.5.2.1.9.2 Soft Mast

T. Kyker-Snowman

Raspberry

Black cherry trees comprise a relatively small percentage of Wachusett's forest canopy. However, bears, small mammals, and over 20 bird species eat cherries (Flatebo et al. 1999). Pin and chokecherries are short-lived, but provide valuable fruit to wildlife. A variety of understory shrubs and trees produce soft mast. Blueberries, serviceberries, dogwoods, and viburnums are abundant. In addition, herbaceous plants such as blackberry, raspberry, wild strawberry, and partridgeberry are utilized by many species of wildlife.

5.5.2.1.10 Mast Management Objectives

MDC/DWM will continue to maintain and encourage a variety of mast-producing plants within the watershed.

Recommended Practices:

- Continue to manage stands to contain multiple species of mast-producing trees and shrubs.
- Foresters will continue to retain productive beech, oak, and hickory trees when they occur as single or scattered trees in stands dominated by other species.
- Retain beech trees with smooth or blocky bark or raised lesions to promote resistance; remove standing trees with sunken cankers or dead patches to reduce sprouting of diseased individuals. Retain some large beech trees that have potential for good mast production, regardless of disease condition.
- Lay out skid trails and roads that avoid vigorous patches of understory shrubs.
- When possible, save all hardwood mast trees that occur in conifer plantations.

5.5.2.1.11 Wildlife Trees

Wildlife trees are often divided into two categories: snags and den trees. Snags are standing dead or partially dead trees at least 6" dbh and 20 feet in height. Den trees are live trees possessing a cavity large enough to serve as shelter for birds and mammals or a site to give birth and raise young. In general, den trees must be 15" or greater in dbh and have a minimum cavity opening of 4" in diameter (Blodgett 1985). Over 50 species of northeastern birds and mammals utilize snag and den trees during part of their lives (Blodgett 1985). Some uses of snags and den trees include cavity nest sites, nesting platforms, food cache, dwellings or dens, nesting under bark, overwintering sites, hunting and hawking perches, sources of feeding substrate, and roosting.

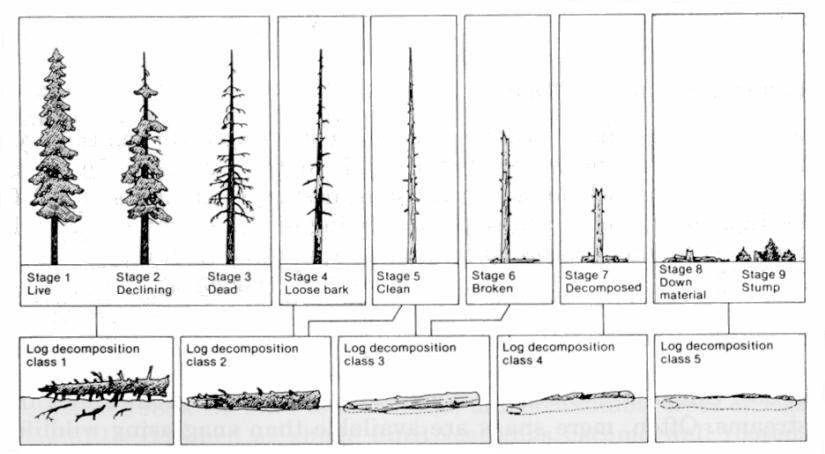
Forestry operations most likely have the greatest potential impact on the number, type, and location of snag and den trees at Wachusett. Thinning, salvage, firewood cutting, and windthrow will result in wildlife tree loss. However, the Division's use of uneven-aged management is conducive to snag management. Single-tree or group selection harvest practices will have only slight to moderate adverse impacts on snag production and retention. Although it would be ideal to retain all wildlife trees, practical field applications make that unlikely. It is possible to maintain an adequate number of snags and dens across the watershed to meet habitat requirements (Table 32).

TABLE 32. OPTIMUM NUMBER OF SNAGS AND/OR DEN TREES PER 100 ACRES BY THREE BROAD HABITAT TYPES.

Size	Forest Interior		Semi-open/Open	Wooded Watercourse
Tree dbh (in)	Dens	Snags	Dens[1]	Dens[1]
> 19	100	0	300	200
10-19	400	400	400	1,400
< 10	200	200	300	900

Source: Payne and Bryant, 1994

[1] Creating snags by deadening trees is not recommended in these habitats.



Source: Payne and Bryant 1994

FIGURE 11. DECOMPOSITION STAGES OF SNAGS AND DOWNED LOGS

5.5.2.1.11.1 Snags

As a tree dies, it progresses through several stages of decay (Fig. 11) and is used by different wildlife at each stage. Newly exposed bare branches provide excellent perches for woodland hawks (Cooper's, sharp-shinned), as well as flycatchers and phoebes. During the loose bark stage, brown creepers and bats may nest or roost under the bark.

As a tree deteriorates, primary excavators (woodpeckers) begin to create cavities. Most northeastern woodpeckers excavate nest cavities in live or dead trees. Secondary nesters then use these cavities. Once trees have decayed to a point where there are no longer branches, it is classified as a snag (< 20 feet tall is a stub). Many insectivorous birds will use the snag for foraging. Finally the snag will either topple to the ground or wear to a stump. The fallen log provides habitat for carpenter ants. In addition, amphibians and reptiles will live in and under the rotting wood. Small mammals also utilize the downed logs.

In addition to the stages of decay, other variables determine a particular snag's value to specific wildlife species. Characteristics such as tree size, location, species, and how it was killed are important determinants of wildlife use (DeGraaf and Shigo 1985). In general, when managing for cavity trees, the rule bigger is better is ideal. Large birds need large diameter trees to excavate nesting cavities. Smaller birds are able to find nest sites in large trees, but it does not work the other way. In addition, large snags usually stand longer than smaller ones. Emphasis is often placed on managing for viable woodpecker populations because their success provides nesting sites for secondary cavity nesters (Table 33).

TABLE 33. NUMBER OF CAVITY TREES NEEDED TO SUSTAIN THE HYPOTHETICAL MAXIMUM POPULATIONS OF NINE SPECIES OF WOODPECKERS FOUND IN NEW ENGLAND

Species	Territory Size (Acres)	Avgerage nest tree[1]		(A) Cavity trees used, minimum	(B) Pairs/100 acres, maximum	Cavity trees needed per 100 acres[2] (A x B)
		DBH (in.)	Height (ft.)			
Red-Headed Woodpecker	10	20	40	2	10	20
Red-bellied Woodpecker	15	18	40	4	6.3	25
Yellow-bellied Sapsucker	10	12	30	1	10	10
Downy Woodpecker	10	8	20	4	10	40
Hairy Woodpecker	20	12	30	4	5	20
Three-toed Woodpecker	75	14	30	4	1.3	5
Black-backed Woodpecker	75	15	30	4	1.3	5
Northern Flicker	40	15	30	2	2.5	5
Pileated Woodpecker	175	22	60	4	0.6	2.4

Source: DeGraaf and Shigo, 1985.
[1] Larger trees may be substituted for smaller trees.
[2] Number of cavity trees needed to sustain population at hypothetical maximum level.

5.5.2.1.11.2 Snag Management Objectives:

Forestry operations will continue to provide a supply of good to excellent quality snag trees, distributed over time and space in order to maintain self-sustaining populations of all cavity dependent wildlife. In areas where good snag trees are lacking, poorer quality trees will be retained until better trees develop.

T. Kyker-Snowman

Snag tree

Recommended Practices:

- When possible, leave all snags within 100 feet of wetlands and riparian areas.
- Maintain a minimum of 6 snag trees per acre; 4 should be > 24" dbh and 2 <24" dbh.
- Avoid disturbing snags from April to July to stay away from nesting birds and denning mammals.
- If snags must be felled during management operations, leave them in place instead of removing them.
- When possible, identify current or potential snags through exterior signs such as fungal conks, butt rot, burls, cracks, wounds/scars from lightening, fire, or mechanical damage, woodpecker holes or cavities, or dead or broken limbs or tops so they can be salvaged.

5.5.2.1.11.3 Den Trees

D. Clark

Potential den tree

Den trees are living, hollow trees used by a variety of mammals including mice, raccoons, squirrels, and bears. In general, there are usually fewer den trees available in an area than could be used by wildlife because large (>15" dbh) rough or rotten trees are relatively rare.

Unlike cavity trees, which have central columns of decay, den trees are hollow or have large hollow limbs, but are still alive and vigorous. Den trees usually have easily visible openings in the sound wood. Some heavily used den trees (e.g., by raccoons) are hardwoods with the top snapped off. Den trees usually have low commercial value, but their value to wildlife is extremely high and long lasting. It may take 100 years to develop large den trees, and once developed some trees (oaks, sugar maple) can live for several hundred years (DeGraaf and Shigo 1985). Once den trees die and fall to the ground, the remnant hollow log may last 25 years providing breeding habitat for redback salamanders and ringneck snakes.

5.5.2.1.11.4 Den Tree Management Objectives

MDC/DWM will provide a continuing supply of good to excellent quality den trees, distributed over time and space in order to maintain self-sustaining populations of cavity dependent wildlife. In areas where good den trees are lacking, poorer quality trees will be retained until better trees develop.

Recommended Practices:

- Retain as many live trees with existing cavities and large unmarketable trees as possible.
- When possible, retain all trees > 29" dbh or at a minimum 2 or more trees >29" dbh per 100 acres.
- Leave at least 1 tree 15-29" dbh per acre.
- Leave at least 1 tree per acre that shows potential for developing into a den tree (broken top, large broken limbs, fire scar); oaks, sugar maples, ash, and hemlock are good trees to select because they readily form natural cavities, or are long-lived.
- Leave all dens trees within 100 feet of a wetland or riparian area.

5.5.2.1.12 Downed Woody Material

Downed woody material refers to slash, logs, large and small limbs, stumps, and upturned tree roots that accumulate on the ground either naturally or through forestry operations. Downed woody debris provides food, cover, and nursery habitat for a range of flora, fauna, and fungi. Downed woody material provides critical wildlife habitat and is used for nesting, shelter, drumming, sunning, as a source and place to store food, and as natural bridges. The specific value of downed woody debris depends on the physical distribution, amount, size, degree of decay, and orientation of debris relative to slope and exposure (Flatebo et al. 1999). Decaying logs also serve as nurse-trees for seedlings and colonization sites for fungi. Too much or too little downed woody material can be detrimental to wildlife. In general, it is best to retain or produce downed woody material that is distributed similarly to what would occur naturally.

Logs are generally considered to be the most valuable downed woody material because of their slow decay and longer persistence. Long logs >16" dbh are especially important wildlife habitat features. As logs age and decay their role as wildlife habitat shifts. Logs supported by branches provide shelter, feeding, and display sites for a variety of birds and mammals. As the log settles to the ground and continues to decompose it may be used by small mammals, snakes, toad, and salamanders for shelter, food, and travel. Large logs with hollow portions may be used as den sites by larger mammals.

T. Kyker-Snowman

Surveying coarse woody debris

5.5.2.1.13 Downed Woody Material Management Objectives:

MDC/DWM will continue to maintain a range of sizes and types of downed woody material and retain or provide downed woody material in sites where it is lacking.

Recommended Practices:

- If snags must be felled during management operations, leave them in place where they fall.
- Avoid disturbing existing downed woody material during harvesting, particularly large (>16" dbh) hollow logs and stumps.
- When possible, leave at least 4 logs of decay class 1 and 2 per acre (Fig. 11); at least 2 of these logs should be >12" dbh and >6 feet long. Hollow butt sections of felled trees can be used.
- Retain as many logs as possible of classes 3, 4, and 5 (Fig. 11).
- On slopes, orient logs along contours and place against stumps when possible.
- In full overstory removal, leave slash on at least 10% of the site in scattered piles or rows.
- Do not add debris to streams and avoid disturbing woody material already in stream.

5.5.2.1.14 Woodland Raptor Nests

Hawks, eagles, owls, falcons, and vultures are all also known as raptors. There are 19 species of raptors that breed in New England. Seventeen of the 19 species are known or potential breeders at Wachusett (Table 34).

T. Kyker-Snowman

Bald eagle nest (Quabbin)

TABLE 34. ACTUAL AND POTENTIAL BREEDING RAPTORS ON WACHUSETT WATERSHED*

Species	Breeding Status	Nest Site Selection
Turkey Vulture	Potential Breeder[1]	Rocky outcrops, ledges, cavities
Osprey	Potential Breeder	Stick nests in trees, snags, poles
Bald Eagle[2]	Potential Breeder	Stick nests in living trees
Northern Harrier[2]	Potential Breeder	On ground, over water
Sharp-shinned Hawk[2]	Potential Breeder	Stick nest on tree limb-usually conifers
Cooper's Hawk	Potential Breeder	Stick nest (may use old crow nest) on horizontal branch in hardwood or conifer
Northern Goshawk	Breeder	Stick nest (used or new) in hardwood
Red-shouldered Hawk	Breeder	Stick nest (new) in tall tree
Broad-winged Hawk	Breeder	Stick nest in tall tree
Red-tailed Hawk	Breeder	Stick nest in oak/white pine
American Kestrel	Breeder	Cavity, nest box
Barn Owl[2]	Potential Breeder	Cavities, buildings, artificial
Screech Owl	Breeder	Cavities and woodpecker holes (Pileated/Flicker)
Great-horned Owl	Breeder	Cavities, old crow, hawk, or heron nests
Barred Owl	Breeder	Large natural cavities or old bird nests
Long-eared Owl[2]	Potential Breeder	Old crow/hawk nest or natural cavity
Saw-whet Owl	Breeder	Natural cavity or woodpecker hole

* Source: Adapted from DeGraaf and Rudis 1986

[1]Potential breeders are raptors not known to be currently breeding within the Wachusett watershed, but capable of breeding there, given the bird's range and habitat requirements.

[2]Listed with the Massachusetts Natural Heritage and Endangered Species Program as an endangered, threatened or special concern species.

Most raptors are predators and feed upon birds, mammals, fish, amphibians, insects, and snakes. While most raptors will eat a variety of animals, some species like the osprey have much narrower food requirements. Compared to other birds, raptors require relatively large home ranges (60->900 acres) in order to meet their food and nesting requirements. Raptor nests are widely dispersed across the landscape in a variety of habitats and forest conditions.

Some raptors will build a new nest each year within their territory, while other raptors will use the same nest for a number of years or claim a nest built by another species. Raptor nest trees must be large and strong enough to support nests ranging from 18" in diameter (broad-winged hawk) to over 3 feet (bald eagle, northern goshawk) (Flatebo et al. 1999). Large diameter broken stubs, closely spaced branches halfway up large white pines, and 3-pronged main forks of mature hardwoods are most frequently used by stick nest building raptors. By maintaining existing nests and identifying good potential nest trees, an area's raptor population can be maintained over a long period.

Many raptors nest early in the year. By February-March, most great-horned owls and some red-tailed hawks and barred owls are incubating eggs. Most other raptors will be incubating by May. Nesting raptors can be vulnerable to human disturbance. There is a wide range of tolerance depending on the species. Some intolerant species (bald eagles, goshawks) may abandon the nest during the early weeks of incubation. Repeated flushing of the female from the nest may also subject the eggs to fatal chilling or the young to predation.

Identifying active nests is critical to ensuring their protection and establishing a buffer zone to minimize disturbance. The easiest, and unfortunately most infrequent, way to detect active nests is to see birds in or around the nest. However, active nests can be identified when no birds are visible by looking for the following indicators:

- Prior to egg laying, some raptors decorate the nest with fresh branches, usually from a conifer.
- After hatching, whitewash (excrement), regurgitated pellets, and prey remains may be found on the ground near the nest tree.
- Raptor nests can be distinguished from squirrel nests by their shape (squirrel nests are saucer-shaped) and lack of leaves (squirrel nests are made mostly of leaves).
- If unsure, consult with an experienced birder or wildlife biologist.

5.5.2.1.15 Woodland Raptor Nest Management Objectives

MDC/DWM will maintain suitable nesting sites for woodland raptors across the landscape over time, and will avoid disturbing nesting pairs of raptors.

Recommended Practices:

- Contact Division's wildlife biologist when planning forest management activities in the vicinity of a bald eagle nest (none currently present on MDC Wachusett properties).
- Inspect mature white pine and hardwood trees for large stick nests when cruising timber. When possible, do not cut trees containing large stick nests and hardwoods with 3-pronged forks.
- Maintain an uncut buffer of at least 66 feet around active raptor nest trees and retain 65-85 percent canopy closure within 165 feet of large stick nests in closed-canopy forests.
- If an active raptor nest is located before or during a scheduled harvest operation, maintain an uncut buffer of at least 66 feet around nest tree, and do not harvest within 330 feet of the nest during April-June.
- If an active raptor nest can be positively identified as belonging to a common or tolerant species (i.e. red-tailed or broad-winged hawk), then harvesting schedules and buffer zones may be relaxed.
- Retain several supercanopy pines near the reservoir shoreline as potential future nest trees for bald eagles.
- Follow appropriate snag tree management guidelines.

5.5.2.2 Considerations During Timber Marking, Harvesting, and Other Land Management Activities.

While careful planning and preparation can mitigate many of the potentially negative impacts on wildlife resources, some specific impacts or events cannot be discovered until operations begin in the field. Locations of active raptor nests, quality den and snag trees, and seeps may not be discovered until foresters begin marking individual trees in a lot. It is during these detailed lot inspections that some of the specific wildlife habitat management recommendations can be implemented. In addition, broader

considerations such as timing of operations, harvesting techniques, record keeping, and other miscellaneous considerations should be addressed in the field.

5.5.2.2.1 Timing of Operations

The timing of land management activities can have a dramatic impact on wildlife species. Some species (bald eagle, great-blue heron, and coyote) are extremely sensitive to human disturbance and may abandon or forgo breeding when repeatedly disturbed. Fortunately, some sensitive species can be easily identified or have known nesting sites. Great-blue herons nest in visible colonies, usually in dead snags over water. In addition, bald eagles build large stick nests that are easily seen and may be used for many years. However, for most other species, their nest, burrow, or den is well hidden and would not be discovered until an operation had already begun. Luckily, most wildlife species tend to nest or den during the spring and early summer when land management activities are restricted. When conflicts do arise, the following procedure will be followed:

- Division personnel will notify the wildlife biologist when land management activities have clearly disrupted a rare or uncommon species' breeding efforts.
- The Division wildlife biologist will assess the nature of the nesting/denning activities and determine what species is involved, what stage of breeding is occurring (courtship, incubation, brooding) and how they responded to the initial disturbance.
- The Division will determine what options will be used to mitigate and avoid further disturbance during the remainder of the breeding season.

Land management activities conducted at other times of the year may unknowingly impact wildlife species, and efforts should be made to reduce these conflicts. Maintenance (mowing, burning, etc.) of fields and open areas should be done after August 1 to avoid destroying nesting birds and mammals (Vernegaard et al. 1998, Jones and Vickery 1998). No activity should occur in or near seeps during winter. If possible, winter activity should be avoided in and around identified wildlife wintering areas.

In some cases, activity during certain times of the year is preferred. Working around vernal pools is often best during winter when frozen/dry conditions minimize rutting and disrupting the forest floor. Further, logging during the fall and winter usually has minimal impact on most wildlife species and may actually benefit some animals by providing additional browse and cover.

Land management activities conducted at any time of the year have the potential to disrupt some wildlife species. However, this disruption is usually small in scale and scattered over the watershed. The benefits derived from actively managing the land outweigh the localized disruption. Because impacts cannot be avoided everywhere, the Division will:

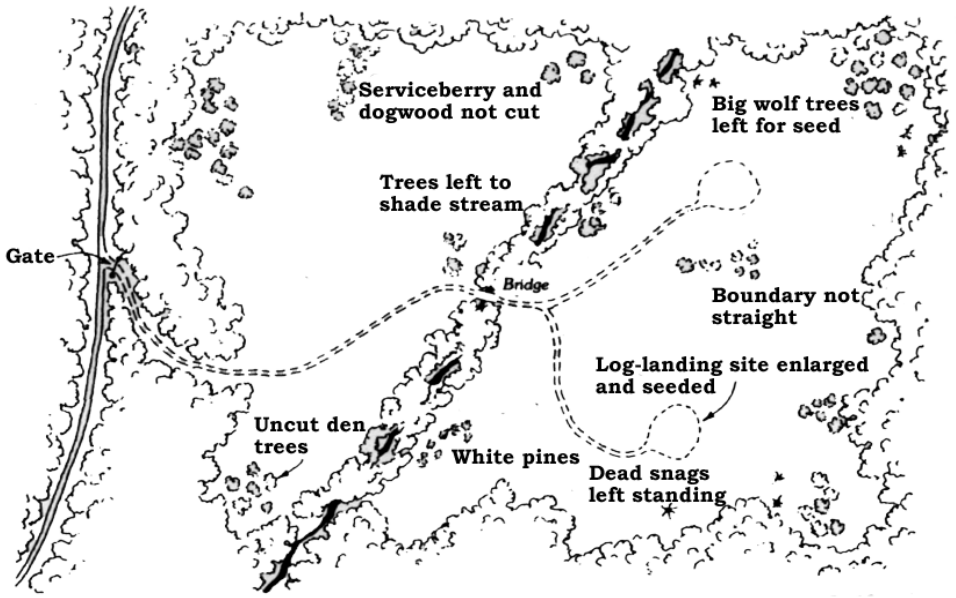
- Continue to gather data on critical and sensitive wildlife and their habitats on the watershed.
- Assess the effects of operations on a case-by-case basis to avoid impacts on special concern species.
- When feasible, shift the timing or location of an operation to avoid these impacts.

5.5.2.2.2 Harvesting Techniques

5.5.2.2.2.1 Group Selection Considerations

When forestry operations use group selection to remove trees in openings 1 acre or greater in size, certain techniques and considerations are used to enhance the area for wildlife. With proper planning, harvesting operations are conducted while still maintaining snags, den trees, and mast producing trees within the opening (Fig.12). In addition, creating an irregular, feathered border will help reduce nest predation and parasitism.

FIGURE 12. FOREST OPENINGS PLANNED WITH WILDLIFE CONSIDERATIONS



Source: Payne and Bryant 1994

5.5.2.2.2.2 Logging and Skid Roads

Access roads are used by the Division to remove wood, control fires, maintain watershed structures, and aid in navigation. Most Division roads within the watershed are narrow, grassy woods trails often referred to as logging roads. The Division's use of uneven-aged management requires harvest operations to extend over a relatively large area and use comparatively short rotation times (20-30 years). As a result, an extensive network of roads are created and maintained.

The effect of forest roads on wildlife and biodiversity depends on the size, type and location of the road. In addition, the frequency in which a road is used and its proximity to resources and other travel routes also determines its impact. Roads effectively create an edge habitat that benefits some species, but has negative effects on species sensitive to disturbance or predators. Roads are often used by some wildlife species as travel lanes, but they may impede the movements of other species that require continuous vegetative cover. Roads may also fragment the forest and isolate individuals or populations.

Constructing and maintaining forest roads on Division property creates a relatively permanent change in the habitat structure of the area. Because traffic on Division roads, particularly at night, is minimal, there is little concern about direct mortality on wildlife populations. The more general concern is that a strip of dirt or gravel under an open canopy can serve as a physical or psychological barrier to animal movements (deMaynadier and Hunter 2000). Studies have documented this barrier affect for small mammals and invertebrates (see deMaynadier and Hunter 2000). In addition, deMaynadier and Hunter (2000) recently documented the barrier affect of forest roads on salamanders.

When logging roads, skid trails, and landings are being planned, certain design features can be incorporated to minimize wildlife impacts:

- Logging roads/skid trails should avoid vigorous patches of shrubs.
- New logging roads should be minimized, and existing roads should be upgraded instead, if possible.
- Roads should be as narrow as possible, ideally one-lane with occasional turnouts.
- Circular routes should be avoided; a cul-de-sac design is better.
- Abandoned roads, skid trails, and landing sites should be seeded with a grass-legume mixture.
- Road intersections should be angled to limit line of sight.
- Large-crowned hardwood trees should be left at the road's edge to provide shade and leaf litter.

5.5.2.2.2.3 Record Keeping

Division foresters, rangers, and other natural resource managers spend a large amount of time walking, observing, and assessing lands within the Wachusett watershed. It is likely that they may observe significant wildlife or important wildlife habitats. Because of the size of the watershed, these anecdotal observations are a critical source of biological information, and may be key to avoiding or mitigating potential wildlife impacts of future land management activities. These observations must be reported to the Division wildlife biologist so that records may be routinely maintained and updated.

5.5.2.2.2.4 Miscellaneous Considerations

In general, the Division's silvicultural practices include cutting trees with weak crown forms that are more susceptible to damage. Some of these trees have wildlife value, and Division foresters should continue to leave some of these trees uncut. For example, trees growing on an angle ("hurricane-tipped") serve as travel routes for arboreal mammals from the ground to the forest canopy. In addition, older trees with large stocky limbs often have protected crotches that are used by nesting birds and mammals. These trees also typically have a high potential for cavity formation. While it is not necessary to maintain all examples of these trees, it is important to retain some during harvesting operations.

Particular combinations of trees species are also valuable to wildlife. Mature oak trees within hemlock or other conifer stands provide food resources within wildlife wintering areas. Small pockets of

hemlock within hardwood stands can serve as significant wildlife cover. Both of these habitat conditions should receive special treatment when feasible.

5.5.3 Population or Impact Control Plans

As a water supply reservoir, the Division's primary responsibility is the long-term protection of the quantity and quality of drinking water. In recent years, the Division has identified certain wildlife species as posing a real and persistent threat to water quality. As a result, the Division has been working to address these wildlife concerns. In general, it is the Division's policy not to interfere with or actively manage native wildlife . However, when wildlife activities impact either the water quality of the reservoir or the integrity of watershed structures or resources, then the Division takes an active role in mitigating these problems. The species of concern and their associated risks are discussed below.

5.5.3.1 Beaver

5.5.3.1.1 General Comments

Beaver can dramatically alter habitats, which in turn can affect other wildlife species and humans. Beaver have been linked to water-borne pathogens and are potential carriers of both G*iardia spp.* and C*ryptosporidium spp* (MDC 1999). In addition, beaver can cause localized damage to roads, culverts, and trees, although the wetland habitat they create is seen as beneficial to a variety of wildlife species. Whether any one colony is seen as beneficial or detrimental depends on the resources affected. Division policy regarding beaver problems takes into account the variety of situations that may arise and applies solutions as needed to offer the best long-term remediation. Because beaver issues can become quite controversial, it is important to discuss and highlight the range of potential beaver impacts on a variety of resources.

5.5.3.1.1.1 Beaver Induced Alterations of Riparian Systems

Beaver are one of the few wildlife species that have the ability to dramatically alter the surrounding habitat to their benefit. These habitat alterations can have substantial impacts on the ecosystem. Changes in vegetation, biotic and abiotic features of the wetland, and effects on other organisms may result. Riparian areas, particularly second- to fourth-order streams and adjacent low-lying areas, are often colonized by beaver (Hammerson 1994). The presence or absence of beaver in an area or region can have a dramatic impact on the predominant vegetation. For example, in West Virginia, the widespread swamp forests common in the early 1900's were most likely the result of the eradication of beaver from the state by the early 1800's (Land and Weider, 1984 *in* Hammerson 1994). Most Division owned riparian areas are forested with a variety of tree species. It is interesting to note that these forested wetlands in Massachusetts may also be an artifact of the beaver's eradication from the state by the late 1700's until their eventual return in 1928. As a result, changes to the riparian landscape caused by expanding beaver populations during the last 20-30 years may appear even more dramatic because beaver were absent from the ecosystem for many decades.

The Division's primary interest is to preserve and protect water quality within the watershed, and riparian areas are certainly an important component to that protection. As a result, it is helpful to summarize the impacts of beaver on the biotic and abiotic components of riparian ecosystems in order to address potential negative impacts from their occupation of riparian areas. One of the most important

factors related to changes in the environment is the structural integrity of beaver dams. Many of the components associated with beaver occupation of riparian zones are contingent on the longevity and stability of the dam itself. Dams that continually wash out may cause water quality problems associated with flooding and the sudden release of sediment and accumulated nutrients. It is usually dams on larger streams (above fourth-order) that are prone to washouts (Naiman et al. 1988). Most of the streams within the Wachusett watershed are first- to second-order streams, although the larger tributaries to the reservoir (Stillwater River, Quinapoxet River) are third-order. However, even some dams on these third-order streams can be prone to washouts, and this has occurred in the past (per. obs.).

The role of beaver in pathogen transmission is addressed separately (see *Quabbin and Wachusett Watersheds Aquatic Mammal Pathogen Control Zone Report***,** (MDC 1999), and beaver are intensively managed by the Division when colonies are located within the defined Pathogen Control Zone (see section 5.5.3.1.2). Beaver located outside the pathogen control zone are generally not assumed to be contributing to water degradation with regards to pathogen transmission or amplification.

The role of beaver in riparian systems was reviewed and is summarized below. The effects of beaver on riparian vegetation, water quality parameters, and ecology are discussed.

5.5.3.1.1.2 Vegetation

Beaver are strictly herbivores and have been described as choosy generalists (Novak, 1987). Beaver are also central place foragers because they return to their lodge or bank den after feeding (Naiman et al. 1988). This is a critical behavioral trait and as a result, beaver foraging is restricted to a relatively narrow band of forest surrounding their pond (Johnston and Naiman, 1990). One study indicated that beaver fed preferentially on a few deciduous species and the number of stems cut declined sharply as distance increased from the pond (Donker and Fryxell, 1999). Beaver will cut and consume a variety of woody vegetation in addition to feeding on aquatic vegetation during the spring and summer. Beaver have a strong preference for certain trees, for instance aspen species.

When beaver colonizes a new riparian area, several important events take place. Typically, a dam is constructed, and the raised water level kills trees within the flood zone. In addition, beaver cut down trees along the shoreline. Although a substantial number of trees may be lost due to flooding, the wetland continues to be buffered by a forested habitat. The forested zone has been pushed back to a new high water level as opposed to lining the stream bank. Along the shoreline, some canopy trees are killed or toppled by beaver, allowing more light to reach the forest floor. Increased light, along with a decrease in competition for water and nutrients, will stimulate regeneration and a release of the forest understory (Johnston and Naiman, 1990). The light penetration may be sufficient enough to allow regeneration of shade-intolerant species (Donker and Fryxell, 1999). While the individual tree selection procedure may differ, this process is similar to that being proposed by the Division (section 5.2.1.5.5) to increase regeneration and vertical diversity along riparian zones. The amount of canopy being removed along the shoreline can vary. After 6 years of continuous occupation, one study site had a 43% reduction in basal area of stems > 2 inches dbh (Johnston and Naiman, 1990). Other studies have indicated that perceived damage may be quite different from actual damage to forest resources. King et al. (1998) indicated that beaver in a wetland in the southern United States were having minimal effect on the forest. In this case it was determined that although tree damage was highly visible by casual observation, beaver were having little impact on tree survival.

In some cases where the overstory is primarily comprised of aspen (some western streams), a majority of the overstory may be removed, and the riparian area could go through a shrub stage until non-browsed tree species grow and overtop the shrub layer. On the Wachusett watershed, aspen species are a

relatively minor component of forested riparian areas. Most riparian areas consist of a diversity of species, making it less likely that all trees will be removed, although the shrubby component of the riparian area may become more dominant as canopy trees are killed.

Beaver induced changes to vegetation along riparian zones can be dramatic when compared to conditions prior to beaver occupation. The primary result of these changes will be a shift in the species composition before and after beaver occupation. The shift may be undesirable if the species being lost are of high economic value (pine, oak, etc.). This is a particular problem in many southern states. In summary, the riparian wetland, although different, is still buffered by a forested habitat that may be more diverse and/or contain a larger shrubby component.

T. Kyker-Snowman

Beaver lodge inspection

5.5.3.1.1.3 Water Quality

As mentioned previously, the Division has a policy in place to address the impact of beaver on pathogen transmission within the watershed. However, because beaver can alter the hydrologic regime of a riparian area, it is important to consider their impact with regards to general water quality parameters. As mentioned previously, most streams within the Wachusett watershed are low-order (first-to-third) systems, and beaver dams constructed in these sites are most likely to remain stable for many years. In recent years, the Division is aware of only a single isolated natural failure of a beaver dam on the Wachusett Reservoir watershed, which occurred on a third-order stream during spring floods (per. obs.).

In many situations, beaver dams can transform a lotic system into a lentic habitat that may resemble a lake or pond. Some important changes associated with this transformation include increased water depth, elevation of the water table, an increase in the wetted surface area of the channel, and storage of precipitation, which is gradually released (Hammerson 1994). In addition, the storage of precipitation can reduce variability in the discharge regime of the stream (Hammerson 1994). Ponding riparian areas can also increase aerobic respiration because the amount in a pond is 16 times that in a stream riffle (Hammerson 1994). In low-order streams there is a shift to anaerobic biogeochemical cycles in soil layers beneath the aerobic pond sediments (Hammerson 1994).

Ponded areas behind beaver dams reduce current velocity within the riparian area, which decreases erosion and stabilizes streambanks (Brayton 1984, Hammerson 1994). In some western states, beaver were introduced into riparian ecosystems that had eroded streambanks and little vegetation along the shoreline (Brayton 1984). The result was a dramatic decrease in sediment transport downstream, streambank erosion was stabilized, and diversity of vegetation began to grow (Brayton 1984). In addition, by slowing down water velocity, there is increased trapping of sediments behind beaver dams, and a resultant decrease in turbidity downstream (Brayton 1984, Hammerson 1994, Maret et al. 1987, Naiman et al. 1994, Naiman et al. 1988). Several studies have shown a substantial amount of sediment being collected behind beaver dams, ranging from 1.5-6 feet (Hammerson 1994).

Some important changes in the chemical and physical properties of the stream occur when an area is dammed. Generally there is a reduction in DO, Al, and SO_4^{2-} and an increase in pH, DOC, Fe, and Mn (Smith et al. 1991, Hammerson 1994). DO reduction is the result of increased retention of organic matter and associated decomposition processes (Smith et al. 1991). By trapping large amounts of sediments and particulates, beaver ponds also trap associated nutrients, including phosphorus (Maret et al. 1987). Other studies have shown that beaver activities may actually increase concentrations of P within the impoundment (Klotz 1998). However, in these studies it is clearly shown that increased concentrations of

P only occur for short distances downstream of beaver ponds before equilibrium processes reduce the concentration (Klotz 1998). Phosphorus is an important element in water supply reservoirs because it is often the limiting factor in the growth of aquatic plants and algae in reservoir systems (Lyons 1998).

One potential problem associated with beaver is the increase in dissolved organic carbon (DOC) within the beaver pond. Though DOC does not directly affect drinking water quality parameters, it is a concern because of disinfection by-products. DOC in beaver ponds increases for several reasons. First, a large amount of wood is transferred into the stream channel, either directly through cutting or indirectly through flooding. In addition, more leaves are collected within a pond than in a stream channel. The carbon turnover rate for this material is less in a ponded area than in a stream with flowing water (Hammerson 1994). Although increases in DOC are a potential concern, a recent study conducted at Quabbin suggested that biological processes and the sheer size of the reservoir prevented these elevated DOC levels from reaching the intake (Garvey 2000). In fact, this study suggests that algae are a much greater concern regarding disinfection by-products at reservoir intakes.

The overall effect of ponding riparian areas is the translocation of chemical elements from the inundated upland to the pond sediments or downstream. A portion of the chemical elements are transported downstream, while most are accumulated in the pond sediments and are available for vegetative growth if the pond drains and succession begins (Naiman et al. 1994).

5.5.3.1.1.4 Ecological Results

As the beaver transforms the stream channel into a ponded area, there are ecological results. The most immediate effect could be the potential loss of habitat for species either requiring large expanses of deciduous trees along a stream or those species living within the stream channel. Because a beaver dam influences only parts of a riparian area, it is unlikely that beaver activity would result in the disappearance of species relying on wooded streams. In New York, experts agree that even after 30 years of expanding beaver populations, species or communities requiring wooded wetlands were probably not adversely affected on a regional or statewide level (Hammerson 1994).

There is often a good deal of concern regarding cold water fisheries and the impacts of beaver impoundments. It is likely that beaver both enhance and degrade suitable fish habitat. Hägglund and Sjöberg (1999) indicated that beaver enhance fish species diversity in Swedish streams. In addition, they speculate that beaver ponds serve as habitat for larger trout in small streams during drought periods. Snodgrass and Meffe (1998) indicated that in low-order streams, beaver had a positive effect on fish species richness. The maintenance of this effect however required the preservation of the dynamics of beaver pond creation and abandonment. The warming of stream water is often cited as a cause of concern regarding cold water fish habitat. McRae and Edwards (1999) indicated that large beaver impoundments would often warm downstream temperatures slightly, but they also served to dampen temperature fluctuations immediately downstream. In addition, when beaver dams were experimentally removed, there was no reduction in the difference between upstream and downstream temperatures. In some cases, dam removal increased the warming rate of the stream (McRae and Edwards 1999). It has been suggested that air temperature (not impoundments) is the single most important determinant of stream temperature in the absence of direct thermal inputs (McRae and Edwards 1999).

The greatest potential negative impact on fish species within the Wachusett watershed may be the inability of spawning salmon to migrate upstream past beaver dams. There has been a noticeable decline in reproduction for landlocked salmon migrating from Wachusett Reservoir (see Section 5.5.5.1), which is partly due to beaver dams impeding migrating fish. Although reproduction has been reduced, recent

data indicate that reproduction is high enough to sustain populations (J. Bergin, pers. comm.). In addition, beaver ponds can alter the suitability of the bottom substrate for both salmon eggs and fry.

The impacts on other organisms are less understood. Amphibian and reptile communities have been studied recently. Russell et al. (1999) reported that species richness and abundance of amphibians were not significantly different among old beaver ponds, new beaver ponds, and unimpounded streams. Reptiles did show a difference among sites. Richness and total abundance of reptiles was significantly higher at old beaver ponds (Russell et al. 1999).

Invertebrate communities exhibit a strong ecological shift as running water taxa are replaced by pond taxa when streams are impounded. This results in an increase in the number of collectors and predators and a decrease in the number of shredders and scrapers (Naiman et al. 1988). While total density and biomass may be 2-5 times greater in ponds than in stream riffles, the total number of species in ponds and streams appear to be similar (Naiman et al. 1988).

5.5.3.1.1.5 Summary

Beaver populations within the Wachusett watershed continue to expand, as beaver mortality rates remain low. As beaver continue to colonize riparian areas, it is important to recognize their role in hydrologic and ecological processes. A careful review of the literature would indicate that it is not the presence of beaver dams, but their persistence through time that has the biggest potential impact on water quality. Maret et al. (1987) felt that it was really the downstream channel that had the largest impact on water quality, as they state, "Our data illustrate the importance of location of beaver ponds along a stream in improving water quality. If water quality is to be maintained downstream from ponds and if nutrient export to a lake or reservoir is to be reduced, then the channel downstream from the pond complex must be stable or the pond complex must be located close to the lake or reservoir." Most streams within the Wachusett watershed are low-order (first to third), and beaver dams constructed across these streams have the strong potential for long-term stability and persistence. On those sites with historically unstable beaver dams or on particularly "flashy" streams, beaver control will be addressed as described in section 5.5.3.1.2.

There is no evidence to suggest a decline in water quality (outside pathogen protection) associated with stable, long-term beaver dams and beaver activity. Most evidence would suggest that beaver ponds (like most wetlands) have either no negative effect on water quality or have a filtering effect that improves water quality by decreasing erosion and trapping sediments, particulates, and nutrients. Changes to vegetation along the banks of beaver ponds results in a species shift away from species preferred by beaver or economically valuable deciduous trees to a larger proportion of woody shrubs and unpalatable or undesirable (by beaver) canopy trees. The more open canopy that results from beaver activity stimulates regeneration and increases habitat diversity.

There are some localized negative aspects of beaver occupation primarily centered on the migration of salmon from Wachusett Reservoir to upstream spawning sites. This is more fully addressed in the next section. Overall, there appear to be either no effects or positive effects on both faunal species richness and diversity when comparing ponds to unaltered riparian wetlands.

There are still site-specific situations where beaver will need to be controlled as detailed in the next section. Outside these specific situations where damage is occurring, there does not appear to be a need to focus beaver control efforts on a watershed basis.

5.5.3.1.2 Beaver Management Policy

Beaver management issues within the Wachusett watershed can be broken down into two categories: Water Quality Protection and Damage to Structures or Resources.

5.5.3.1.2.1 Beaver and Water Quality Protection

There is consensus in the scientific community that beaver can play an important role in the transmission of harmful pathogens to humans through water supplies. The Division recently completed a report that summarizes these concerns and addresses management recommendations for beaver at both the Wachusett and Quabbin watershed reservoirs. For more detailed information regarding this see the report titled, *Quabbin and Wachusett Reservoirs Watersheds Aquatic Wildlife Pathogen Control Zones* (MDC 1999). This report clearly defines a protection zone around each reservoir where beaver will be eliminated and excluded on a continual basis for water quality protection. The report does not address beaver management for water quality protection outside this protection zone. Situations outside the protection zone and in which water quality is being threatened will be handled on a case-by-case basis.

5.5.3.1.2.2 Damage to Structures or Resources

Outside the water quality protection zone, it is the Division's general policy to allow unrestricted beaver occupation. However, the following situations are examples where beaver activity may be discouraged, mitigated, or modified:

- Beaver dams on unstable or flashy streams with a history of, or potential for, regular washouts.
- Beaver activity that threatens rare or uncommon plant or animal communities.
- Beaver activity that precludes the use of necessary access roads needed for watershed maintenance, management, or protection.
- Beaver activity that threatens the proper functioning or structure of dams, culverts, and other parts of the water supply infrastructure.

When there is a conflict with a beaver colony, the following procedure will be used to mitigate the damage. Division personnel encountering problem beaver sites will fill out the Beaver Dam Observation Form and return it to the Division wildlife biologist and Wachusett section superintendent. Upon review, the wildlife biologist and superintendent will decide the most appropriate control activity for each site. Guidelines for determining proper mitigation are discussed below in Section 5.5.3.1.2.3. Appropriate permits will be obtained when they are necessary (e.g., removing a section of dam to install a flow control pipe). When lethal measures are determined to be the best alternative to alleviate the problem, specific guidelines will be followed.

5.5.3.1.2.3 Guidelines for Determining Proper Mitigation for Problem Beaver

MDC/DWM personnel who encounter problem beaver sites will fill out the Beaver Damage Observation Form and return it to the MDC wildlife biologist and Wachusett Superintendent. Upon review, the wildlife biologist and superintendent will decide on the most appropriate control activity for each site. Options available include: water level control devices, dam stabilization, culvert protection, or lethal removal. Site-specific control options will be chosen based on site conditions, history of the site, and type of damage occurring. The goal is to try to provide the most effective control possible that mitigates the problem. Lethal removal will be a viable option, but will only be used if all of the following criteria for the site are met (except beaver problems associated with water quality issues as addressed in the report; *Quabbin and Wachusett Reservoirs Watersheds Aquatic Wildlife Pathogen Control Zones,* (MDC 1999):

- Beaver are causing documentable (observation, photographs, etc.) damage to MDC infrastructure (roads, culverts, bridges).
- Other, non-lethal means (water level control devices, fencing, etc.) would not be able to mitigate the problem because of limitations in access, maintenance, or effectiveness.
- The MDC property being damaged is essential and cannot be temporarily abandoned.
- Lethal measures can be implemented within appropriate laws and guidelines and without threat to the safety of the public, domestic animals or other wildlife.

When lethal measures are to be used, the following procedure must be followed:

- The above criteria must be documented (using Beaver Damage Observation Form) prior to any action.
- Beaver will be removed through shooting (12 gauge shotgun), or live-trapping using Hancock, Bailey or cage traps followed by shooting. Conibear traps can only be used after non-lethal measures have been tried and have failed and live trapping has been conducted for 15 days.
- Two staff will be present at all time and will include one supervisor. The supervisor will be a Water System Storage Foreman II or higher. All staff participating will have a Firearms ID card. Any persons using live-traps must be properly trained beforehand by a designated trainer.
- Every attempt will be made to retrieve beaver carcasses, and upon retrieval they will be buried at a suitable location.
- Personnel taking part in beaver control activities will take adequate precautions (washing hands/wearing rubber gloves) to prevent transmission of *Giardia* and *Cryptosporidium* and other pathogens.
- The supervisor in charge will document all actions and complete the proper form (Beaver Removal Documentation Form) copies of which will be sent to the Wildlife Biologist and Superintendent.

5.5.3.2 Muskrat

In the past, most of the attention regarding water quality and wildlife has focussed on beaver and their role in pathogen transmission. Recently, the Division identified muskrat as another key species in their pathogen prevention program. The muskrat impact control program in this plan is focussed on water quality protection within the reservoir. A detailed description of the program can be found in the MDC document**,** *Quabbin and Wachusett Reservoirs Watersheds Aquatic Wildlife Pathogen Control Zones***, (**MDC 1999). In addition, muskrat have the potential to cause damage to watershed infrastructure. In situations where muskrat are causing damage to these structures (i.e. dikes, dams),

appropriate measures will be used to mitigate the damage. Measures may include lethal removal of the individuals, followed by habitat manipulation to discourage reoccupation.

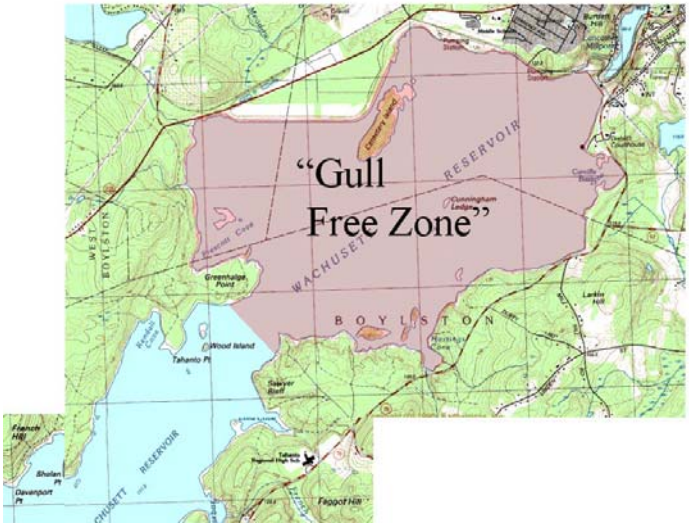
5.5.3.3 Gulls, Geese, and Other Waterfowl

5.5.3.3.1 Gulls

Wachusett Reservoir provides a daytime loafing area and nighttime roosting site for a variable number of gulls. Three species (ring-billed, herring, great black-backed) of gulls are the most common. Gulls numbers generally begin to increase in late summer and early fall and reach a maximum during the winter months (particularly when other water bodies freeze). By spring and early summer, most gulls have left the area to migrate to their summer breeding habitat. Although gulls are present at the reservoir all day, most gulls will leave the nighttime roost soon after sunrise. The gulls disperse to spend the day at feeding sites, including landfills and fast-food eateries. By late afternoon, most gulls are returning to the reservoir to spend the night. As a result, harassment efforts are focussed during the late afternoon to early evening.

The Division has been monitoring bird populations at Wachusett Reservoir since 1991. Early studies provided evidence that a high number of gulls in the northern portion of the reservoir correlated with high fecal coliform counts at the Cosgrove Intake. In response to these studies, the Division initiated a bird harassment program in 1993. Since 1993, the Division has conducted a yearly harassment program to scare birds out of the Bird Harassment "Gull-Free" Zone (Fig. 13). The harassment program is a year-round effort, although active harassment activities usually occur from September until the reservoir freezes. Daily harassment activities are supervised and/or carried out primarily by MDC Environmental Quality personnel. In addition, MDC maintenance personnel conduct harassment from boats when necessary. MDC Natural Resource staff are responsible for program monitoring, passive harassment techniques, and program development. Active harassment is done using pyrotechnics, a human presence, and boats. Birds are either scared from shore using "Shell-crackers," or a boat is used to scare and herd the birds to the southern end of the reservoir.

FIGURE 13. BIRD HARASSMENT "GULL-FREE" ZONE



Control efforts during the active harassment period of the program are conducted 7 days/week until the reservoir freezes. During icy conditions when boat use is impossible, the Division uses a hovercraft to harass the birds. In addition to the active harassment efforts carried out, the Division employs several passive techniques designed to be used in conjunction with the active harassment program. These techniques include using netting to exclude birds from critical areas, erecting structures that support "scary-eye" balloons, using

remote activated sound deterrent stations, and habitat manipulation to discourage bird use. Coupled with the harassment activities at the reservoir, the Division has worked with other EOEA agencies to develop regulations to control state solid waste landfills. In the fall of 1998, DEP instituted regulations that required all municipal solid waste landfills to harass and discourage gulls from feeding and loafing at their sites. In addition, new landfills must submit a written gull harassment program prior to receiving their operating permit. To date, the new regulations have been successful in reducing the number of gulls at area landfills. However, more diligent monitoring and enforcement is needed to ensure continued compliance.

A unique feature of Wachusett Reservoir has been the occurrence of a nesting colony of herring gulls on an island in the northern portion of the reservoir. Historical records indicate that gulls were nesting on the island in the 1960's and even makes reference to attempts by the Division to collect gulls eggs in order to discourage nesting. Nesting most likely continued until the 1990's when more active measures were taken to remove and discourage nesting by these birds. In 1997, a small colony of ring-billed gulls attempted to nest on the same island. Again, these birds were actively controlled to prevent successful nesting. Since 1997, gulls at the Reservoir have made no nesting attempts. However, it is the Division's policy for zero tolerance of nesting gulls on the Reservoir. Left uncontrolled, nesting gulls colonies have the potential to expand greatly, which would be counterproductive to harassment goals.

Since 1993, the bird harassment program has been very successful in reducing the number of birds located in the northern portion of the reservoir. As a result, fecal coliform counts for that time period have been extremely low as well. There has only been 1 exceedance since the program began in 1993. The Division will continue the harassment program indefinitely and continue to make modifications and adjustments to ensure its long-term success.

5.5.3.3.2 Geese

Canada geese are present at Wachusett Reservoir year round. There are approximately 100 resident geese that only leave the area when the reservoir freezes. In addition, during the fall and winter, several hundred more geese utilize the reservoir during migration. From a water quality perspective, geese are a lower priority species than gulls because of their feeding behavior and population levels. However, the Division still considers geese to be a high priority species, and geese are actively harassed during the bird harassment program. Although less responsive to harassment efforts, all of the active and passive harassment techniques are geared toward scaring geese as well as gulls.

In addition to actively harassing geese at the Reservoir, there has been a strong effort to reduce the local goose population through an intense population reduction program. Since 1995, an attempt to identify all Canada goose nests on the Reservoir has been made. Once identified, the eggs in each nest are treated to prevent hatching. The goal of this program is the gradual long-term reduction in the resident adult goose population. This program will continue in the future.

T. Kyker-Snowman

Canada goose on nest

5.5.3.3.3 Other Waterfowl

Other than Canada geese, Wachusett Reservoir also harbors a variety of waterfowl. During the spring and summer, there is a relatively small number of resident mallard ducks. During the fall and winter, this number can increase substantially, and on some occasions there may be several hundred

ducks at the Reservoir. In addition, during peak migration times, other duck species (e.g., ring-necked, mergansers, ruddy) utilize the reservoir as a layover. Fortunately, most ducks continue their migration south or north within a few weeks. During the time they are located on the reservoir, these species of ducks are included in the harassment efforts if they are located within the bird harassment zone.

A final species of concern is the double-crested cormorant. A seasonal resident at the reservoir, cormorants typically begin to show up in mid-late summer after the breeding season has ended. They are present during the fall and winter and typically leave the reservoir in the spring. Although relatively scarce (100-200 individuals) when compared to gulls and geese, these birds are extremely difficult to harass. While other bird species tend to fly when scared, cormorants often dive and swim beyond the limit of harassment. The cormorant is included as a target species in the bird harassment program, and research will continue to develop new and better harassment techniques.

5.5.3.4 Burrowing Animals

The burrowing activity of certain wildlife species such as woodchucks, moles, and voles can cause damage to the integrity of earthen dams, dikes, and other watershed structures. To date, Wachusett Reservoir has not had a situation where this type of damage was occurring. However, if an engineering survey concluded that such activity was damaging watershed structures, then appropriate mitigation steps would be taken. Most likely, lethal control methods would be used to remove the animals and then habitat modification would occur to discourage reoccupation.

5.5.3.5 White-Tailed Deer

White-tailed deer populations are increasing in most of the northeast. There is growing concern about these increasing populations and their impact on natural resources (Healy 1999, Alverson and Walker 1999, McShea and Rappole 1999). Deer populations within Massachusetts are increasing in the central and eastern part of the state (MassWildlife, pers. comm.). White-tailed deer can thrive in suburban environments where there is abundant food, few predators, and enough wooded areas to provide cover. Coupled with expanding deer populations is increased fragmentation of the landscape that can isolate these wooded reserves and in many cases prevent people from effectively hunting white-tailed deer populations. Even in areas where hunting is feasible, there is growing concern that both hunter interest and hunter recruitment is declining. In many situations, these circumstances can lead to overabundant deer densities.

Deer populations within the Wachusett watershed have been estimated at 15-20 per mi^2 (MassWildlife, pers. comm.). There is further evidence to suggest that populations within the watershed are expanding. Although expanding deer populations may pose a concern within portions of the Wachusett watershed, it is doubtful that the same large-scale problem witnessed on the Quabbin Reservation would occur here. Landuse patterns and land history at Wachusett differ dramatically from both the Quabbin Reservation and Ware River watersheds. Quabbin Reservation did not allow deer hunting for many decades, and its large blocks of contiguous forest nurtured very high deer densities (40-60 mi^2). These high deer densities severely impacted forest regeneration and necessitated the initiation of a deer reduction program that has been conducted on the Reservation since 1991 (See *Quabbin Reservation White-tailed Deer Impact Management Plan*, MDC 1991). In contrast, the Ware River watershed has allowed unrestricted hunter access to its properties since its establishment. To date, there have been no overbrowsing or regeneration problems, even on the larger blocks of land.

The Wachusett watershed differs from both the Quabbin and Ware River and is characterized by smaller parcels scattered around the watershed. Many of these parcels have been acquired recently by the Division and were traditionally hunted. Division land at Wachusett is separated into hunting and no-hunting zones (Fig. 14). The no-hunting zone is concentrated on lands immediately surrounding the reservoir. Public hunting is allowed on a majority of the Division's lands away from the Reservoir. Given the high degree of fragmentation within the watershed, the Division recognizes the potential for some of its lands within the no-hunting zone to serve as refuges for an increasing deer population. It is important to note that although no public hunting is allowed within this zone, there is anecdotal evidence to suggest that poachers access these areas. In addition, domestic dogs have been observed chasing deer with this zone.

Given the lessons learned at the Quabbin Reservation, Wachusett staff is primarily concerned with the potential impact high deer densities may have on tree regeneration and growth within the no-hunting zone. The Division does not scientifically monitor forest regeneration within the Wachusett watershed. However, Wachusett foresters routinely walk and inspect a variety of forest stands and sites within the watershed and make anecdotal observations about regeneration. To date, there have been no concerns regarding the amount or diversity of tree regeneration (G. Buzzell, pers. comm.). It is interesting to note that although forest regeneration does not appear to be impacted, there are indications of localized severe browsing. The arborvitae hedge surrounding the reservoir has a well-defined browse line that has been visible for many years. In addition, several ornamental plants in surrounding residential areas have been severely browsed (pers. obs.).

Given the trend of rising deer populations, shrinking hunting opportunities, and a declining hunter base, the Division recognizes the potential for some of its no-hunting lands to experience overabundant deer populations. Although primarily focussed on the impacts of overabundant deer on tree regeneration, the Division also recognizes that other social issues related to overabundant deer may become more prevalent. These include increased deer/vehicle collisions and personal property damage. As a result, the Division will examine the feasibility of initiating long-term monitoring of both deer herd dynamics in the no-hunting zone and tree regeneration across the watershed. Regeneration plots would be established and monitored in both hunted and non-hunted areas to scientifically assess the impact of white-tailed deer browsing on tree regeneration and growth. In addition, surveys may be initiated to monitor deer population trends over time. The Division would collaborate with MassWildlife to design a combination of spotlight surveys and/or line transects to index the deer population within the no-hunting zone. Further the MDC will consider expanding its hunting zone to include more lands east of Interstate I-190. Finally, if deemed necessary, the MDC will consider initiating a controlled hunt inside the gated properties that surround the reservoir in order to reduce deer densities.

FIGURE 14. AREA ON MDC/DWM LAND WHERE HUNTING IS PERMITTED

go to www.state.ma.us/mdc/WachusettLMPfig14.pdf (file size: 2.2 MB)

5.5.4 Active Management to Enhance Habitat for Selected Wildlife Species

5.5.4.1 Early Successional and Contiguous, Mature Forest Habitats

Land management activities at Wachusett primarily focus on enhancing the multi-aged, multi-species forest. As a result of this decision, some wildlife species will benefit greatly while other species will be restricted. Although the DWM forest management will focus on uneven aged, small group selection silviculture, it is still possible to manage for a mosaic of habitat types where conditions allow. There is widespread concern about wildlife species that utilize or depend upon early successional habitat (including some species in Table 29) because the amount and quality of available habitat continues to shrink. Similarly, there is concern for species dependent on closed canopy mature forest. As more land becomes developed and fragmented, there remain fewer tracts of unbroken forest, reducing available habitat for species requiring closed canopy mature forest.

Management techniques needed to create and sustain these types of habitat differ substantially from the predominant management techniques employed by MDC/DWM. In general, large-scale even-aged forest management techniques are needed to create large areas of early successional habitat, and subsequent stands of contiguous, mature, closed-canopy forest. Large-scale even-aged forest management is impractical and undesirable within the Wachusett watershed given the relatively small size or narrow configuration of both public and private forests scattered around the landscape. In addition, an abundance of wetlands and streams criss-cross the landscape, restricting large-scale removal of complete overstories. In order to be beneficial for the most wildlife species, even-aged blocks need to be a minimum of 10 acres in size. While scarce, there are areas on the watershed where the Division may be able to utilize this management activity to provide early successional forest habitat. It is also feasible that already existing fields, brushy meadows, and young forest areas can be maintained and enhanced to provide early successional habitat. The MDC recognizes the importance of field habitat within the watershed, and as described in Section 5.4.6, will take active measures to maintain and enhance existing fields.

5.5.4.2 Common Loon Management and Research

Common Loons (*Gavia immer*) are a listed species of Special Concern in Massachusetts. These birds typically nest on large lakes and reservoirs with an abundance of fish and suitable nesting locations (typically small islands or peninsulas). Of the 22 territorial pairs in Massachusetts, 18 occur on MDC water bodies, and 5 pairs are within the Wachusett watershed. Because the MDC is responsible for a majority of the nesting loons in the state, significant time and effort is expended protecting and enhancing these birds. Artificial loon rafts are constructed and deployed, individuals are monitored during the nesting season, and certain management activities that could disturb nesting loons are suspended during the nesting season. To further enhance the MDC's ability to effectively manage this species, an intensive research project has been initiated (pending adequate funding) to provide more detailed information about loons nesting on MDC water bodies.

The proposed research project will provide an in depth study of all loon pairs on MDC property.

Specifically, the goals of the project are as follows:

- Identify potential stressors that may impact loon presence and reproductive success. Rank stressors and habitat features to create a quantitatively comparative index of loon territory quality.

- Weekly, monitor territorial pairs of Common Loons to ascertain reproductive status and success. Include other lakes with potential habitat when relative.
- Continue the capture and color marking of loons for remote monitoring of individual reproductive performance and movements.
- Collect blood and feather samples from captured loons for contaminant analysis and evaluation of the effects of contamination and other stressors through biomarkers.
- Establish a volunteer network of lake residents and other interested parties for long-term monitoring efforts that will be coordinated by the Loon Preservation Committee.
- Construct a management plan that addresses territory-specific requirements.
- Integrate collected information into a regional model to spatially construct risk assessments for multiple stressors.

When the project is complete, the MDC should have acquired intimate knowledge of each pair of territorial loons and been provided with specific recommendations to take to ensure continued reproductive success and survival.

E. Mitchell

Salmon on a fly!

5.5.5 Fisheries Management

5.5.5.1 General status of fishery

Wachusett Reservoir is a large, deep, cold water body that provides abundant trout and salmon habitat. These fish provide a popular resource for fisherman, as well as an abundant food source for piscivorous birds such as Common loons, mergansers, and herons. A 1998 MDC survey showed approximately 27,000 anglers spend over 83,000 hours fishing for lake trout, landlocked salmon, smallmouth and largemouth bass, stocked trout, yellow perch, and other panfish between April 1 and November 30. This ranks Wachusett Reservoir in the top ten most popular fishing areas in the state.

Twenty-seven species of fish occur within the Wachusett watershed (Table 35); none of these fish are listed by the state as rare, endangered, or of special concern. Five species spend their entire lives in the reservoir tributaries. Five other species (American eel, brook trout, brown trout, rainbow trout, and landlocked salmon) must leave the reservoir to spawn. The remaining 19 species are able to complete their entire life cycles in the reservoir.

TABLE 35. SPECIES OF FISH FOUND WITHIN THE WACHUSETT WATERSHED.

Species	Reservoir	Direct Tribs	Indirect Tribs	Status[1]
Brook Trout	√	√	√	N,A
Brown Trout	√	√	√	I,P
Rainbow Trout	√	√		I,C
Lake Trout	√			I,A
Landlocked Salmon	√	√		I,C
Atlantic Salmon	√			I,R

Species	Reservoir	Direct Tribs	Indirect Tribs	Status[1]
Rainbow Smelt	√	√		I,A
Largemouth Bass	√	√	√	I,A
Smallmouth Bass	√			I,A
Rock Bass	√			I,A
Chain Pickerel	√	√	√	N,A
Yellow Perch	√	√	√	N,A
White Perch	√	√		I,C
Brown Bullhead	√	√		N,A
Yellow Bullhead	√			I,C
Golden Shiner	√	√		N,C
Bridle Shiner	√			N,C
Spottail Shiner	√			N,C
Fallfish	√	√		N,C
White Sucker	√	√	√	N,C
Banded Killifish	√			
Redbreast Sunfish	√			N,R
Pumpkinseed	√	√	√	N,C
Bluegill Sunfish	√			I,C
Black Crappie	√	√		I,C
Tesselated Darter	√	√		N,A
Walleye	√			I,E

[1] N=native; I=introduced; A=abundant; C=common; P=present, but not common; R=rare, limited presence; E=extirpated

5.5.5.2 Management objectives

The regular watershed protection that safeguards the water quality in the reservoir also adequately protects the 19 species of fish that reside and remain in the reservoir. Continued reservoir operations should provide long-term protection to these species. There is concern that the 5 fish species that spawn in reservoir tributaries may be subjected to management or natural events that negatively impact these species. Specifically, the installation of silt curtains at the mouths of certain tributaries, an increasing beaver population, and the erosion of stream banks are all potentially negatively impacting the 5 tributary spawning fish species.

5.5.5.2.1 Silt curtains

In 1998, the DWM installed two experimental silt screens in Gates Brook cove to detain and precipitate sediment from Gates Brook before it could enter the reservoir. The screens have been extremely successful in trapping sediment and particles. In approximately 1½ years since their installation, the curtains have trapped ~6 feet of sediment. In several locations, the trapped sediment has reached the top of the screens and water is flowing over the curtain. Both screens were designed with fish passage openings in the middle of the curtain. However, a limitation in the design impedes fish migration. The flow from Gates Brook caused the curtain to billow, moving the fish openings from a vertical to a horizontal position, thereby making it impossible for fish to detect and/or pass through the openings. In addition, the diffused discharge made it difficult for salmonids to find the openings in the curtain. Removal of the trapped sediment was done in the fall of 1999. In addition, a portion of the

curtain was opened during the early fall of 1999 to allow salmon migration upstream. The DWM will reassess the design of the curtains and their impacts on migrating salmonids, with the hope of designing more effective openings.

5.5.5.2.2 Beaver effects on fish

Massachusetts's beaver population has grown steadily since their reintroduction in the mid 1950's. In 1996, a statewide trapping ban contributed to an increasing beaver population. Statewide estimates for beaver populations are approximately 60,000 animals, up from 18,000 animals in 1996. Beaver populations along the Stillwater River (a major spawning site for salmonids) are showing similar trends. A MassWildlife survey in 1995 located 4 beaver dams along the Stillwater River. The same survey done in 1999 located 25 beaver dams. Beaver impound streams to create stable water levels, which provides security and a storage site for winter food. Large beaver dams also block upstream passage for spawning adult salmonids. The few adults that manage to traverse the dams encounter unfavorable spawning sites. Water temperatures within the impoundment generally increase above ambient stream temperatures. Temperature sensitive species such as brook and brown trout may be killed when water temperatures in the impoundment are too high. Although of particular concern on the Stillwater River, there is significant potential for beaver dams on other tributaries in the watershed. The direst outcome could result in the extirpation of most salmonid populations from the watershed.

The DWM's policy on beaver is explained in section 5.5.3.1.2. It is unlikely that the DWM would be able to correct the problem in the foreseeable future. Further, it is doubtful that efforts to control beaver on the Stillwater River would have a lasting impact on either local beaver populations or migrating salmonids. The Stillwater River offers excellent beaver habitat, and under current DWM mandates and priorities, population control in this area is not possible. Unless regulated commercial trapping is reintroduced on a statewide level, beaver populations are likely to continue to grow on MDC/DWM properties.

5.5.5.2.3 Sediment

Sediment transport is a normal, natural process for a stream. Unfortunately, human activities can accelerate or increase sediment loads. While most MDC/DWM roads are not sanded during the winter, some roads are maintained. Sanding roads during winter can cause large sediment loads during spring. In addition, construction and human activity around streams can add sediment to streams. The increased sediment load results in fine sand settling over gravel stream bottoms in sections where stream flow is slow to moderate. Settling occurs because the stream cannot transport the additional load of sediment. When this fine material is deposited on graveled streambeds it suffocates salmonid eggs that were laid in or on the streambed.

The DWM is concerned about increased sediment loads entering the reservoir, although historical accumulations have been extremely low. Detention basins have been constructed at some locations to detain and trap sediments. Some potential solutions to this problem would include constructing catch basins with sediment traps on all direct road drains. In addition, old sediment basins could be rebuilt to include sediment traps. If installed, catch basins would be cleaned twice a year in the spring and fall.